CCASIONAL PAPER 120 MAY 195

STATION LIBRARY COPY

FOREST PLANTING SITES IN NORTH MISSISSIPPI AND WEST TENNESSEE

Walter M. Broadfoot

SOUTHERN FOREST EXPERIMENT STATION
Chas. A. Connaughton, Director
New Orleans, La.
FOREST SERVICE, U.S. DEPT. OF AGRICULTURE

FOREST PLANTING SITES IN NORTH MISSISSIPPI AND WEST TENNESSEE

Walter M. Broadfoot
Southern Forest Experiment Station

Forest plantations in north central Mississippi and western Tennessee can produce merchantable timber on much land which erosion has made useless for other crops. Forest plantings usually can decrease, stop, or forestall erosion economically.

This paper describes the most important sites in the area, predicts what may be expected if they are planted to trees, and suggests the tree species and planting procedures most likely to succeed. The opinions and conclusions are based on field observations during the past three years. The majority of these observations were made during detailed study of 159 plantations on which establishment records were available.

Soil Conditions Affecting Tree Growth

Plant growth is governed chiefly by the ability of the soil to supply water, air, and plant food to the roots. Any soil condition which restricts these essentials also restricts tree growth.

In the light of these requirements, three important influences can be used to evaluate site quality. They are soil depth, fertility of the surface soil layer, and soil moisture conditions.

Plant roots extend several feet into the soil in search of water and nutrients. When an impenetrable layer of hardpan or poorly drained soil keeps tree roots near the surface, they cannot reach enough food and water, and growth is poor. Except in gullies, depth to an impervious layer ordinarily will not vary greatly within fields. In general, the extent to which fertility and soil moisture affect the survival and growth of planted trees depends on whether an impervious layer lies close enough to the surface to deny roots the necessary growing space. Soils more than 24 inches in depth are considered deep in this publication, and those less than 24 inches in depth are considered shallow.

A serious effect of erosion has been to wash away the topsoil, the most fertile part. With trees as with row crops, the less topsoil in the surface 6 inches, the poorer the growth. When only subsoil or parent material is found on the surface, growth is likely to be very poor.

In order to learn the nature, depth, and position of the various soil layers in old fields, some digging may be necessary. Where the soil has not been eroded or otherwise moved or mixed, the topsoil is the surface layer, subsoil the second layer, and parent material the third layer. The topsoil is normally darker and greyer than the reddish-brown subsoil. Parent material, from which the subsoil develops, may not differ in color from the subsoil. In this area it ordinarily occurs at depths of more than three feet below the ground surface, unless serious erosion has removed the topsoil.

In gullies, the composition, depth, and location of the various soil layers can be learned by examining the sides and bottoms. Near the base of gully banks and on the gully bottoms the kind of soil in the surface layer will depend largely on whether or not erosion is taking place. On areas where erosion has stopped or where soil has been deposited, the surface layer will most likely be of mixed topsoil, subsoil, and parent materials. When the materials are mixed, as in gullies, the composition can be estimated from the color and general appearance. Impervious layers are easily recognized as compact, mottled zones in the case of hardpan, or as grey, waterlogged zones in the case of poorly drained soils.

The moisture condition of a site is governed chiefly by the position of the site on the slope. Sites on lower slopes and in minor bottoms are naturally moister than sites on ridges and upper slopes.

The natural moisture condition of a site is also affected by the texture of the soil, the direction in which the slope faces, and the kind of plants already growing on the site. Fine- and medium-textured soils are wetter than coarse sands. North and east slopes are usually more moist than south and west slopes. Soils covered by plants or litter absorb more water than those that are bare.

Types of Planting Sites

These three major influences--depth, fertility, and moisture--combine to determine planting sites. Table 1 summarizes the most common sites in north central Mississippi and western Tennessee, and indicates the general results that may be expected on them. These sites are best suited to pines. Hardwoods are recommended for only two of them.

In the table, the probable success of plantings for timber production and erosion control has been rated on a five-point scale

Table 1.--Pine planting sites in north Mississippi and west Tennessee

Soil and site	Old-field sites		Gully sites	
	Planting objective	Probable success	Planting objective	Probable success
I. Soil 24 inches or more deep				
A. Surface 6 inches mostly topsoil				
1. Moist--lower slopes and bottoms	Timber	Excellent 1/	(2/)	...
2. Dry--ridges and upper slopes	Timber	Good to excellent	(2/)	...
Special cases--very rapid internal drainage	Timber	Fair to excellent	(2/)	...
B. Surface 6 inches mostly subsoil				
1. Moist--lower slopes	Timber;erosion control secondary	Good	Erosion control;timber secondary	Fair to Good
2. Dry--ridges and upper slopes	Timber;erosion control secondary	Fair to good	Erosion control;timber secondary	Fair
C. Surface 6 inches mostly parent material	(2/)	...	Erosion control	Poor
II. Soil less than 24 in. deep				
A. Surface 6 inches mostly topsoil				
1. Moist--lower slopes and bottoms	Timber	Good 1/	(2/)	...
Special cases--very poor internal drainage	Timber	Poor to fair	(2/)	...
2. Dry--ridges and upper slopes	Timber	Fair to good	(2/)	...
B. Surface 6 inches mostly subsoil				
1. Moist--lower slopes	Timber; erosion control secondary	Fair	Erosion control;timber secondary	Poor to fair
2. Dry--ridges and upper slopes	Erosion control;timber secondary	Poor to fair	Erosion control	Poor
C. Surface 6 inches mostly parent material	(2/)	...	Erosion control	Very poor

1/ Good results may be expected from planting hardwoods on site IA1, and fair results on site IIA1. On all other sites, hardwoods may be expected to be poor or very poor and cannot be recommended for planting.

2/ Such sites are not commonly found in this area.

running from excellent through good, fair, and poor, to very poor (virtual failure). Survival, vigor, and growth, together with completeness of erosion control by needle litter and vegetation other than trees, have entered into this classification. It should be emphasized that all but the very poorest results may be worth getting. An erosion-control gully planting on a shallow, dry soil where the surface layer is mostly subsoil may be worth the cost of planting even if only part of the trees live. These small trees will begin to slow down erosion and eventually they will do much to stop it. Frequently they will control it more cheaply and effectively than any other means.

Following are fuller descriptions--numbered to correspond with the table--of the chief sites in the region.

IA1. Soil deep (impervious layer, if present, 24 or more inches below surface); surface 6 inches mostly topsoil; moist.--Such sites occur mostly near or at the bottoms of slopes. They are found mostly in old fields because gullies have only very small areas in which topsoil predominates in the surface 6 inches. Moisture may be abundant because the site is near the bottoms of slopes, and also because soil texture is fine, the slope faces north or east, plant cover or litter is good, or because a combination of these factors occurs. The soil is deep enough to prevent excessive wetness or waterlogging. These are the best possible sites for pine timber production, and hardwoods may do well. In general, pines planted on these sites begin to reproduce themselves within 10 years after planting, and are invaded (fig. 1) by oak, ash, and other high-quality hardwoods that require good sites.

IA2. Soil deep; surface 6 inches mostly topsoil; dry.--Except for small patches these sites, like the preceding ones, occur mostly in old fields, but generally on the upper slopes. Their dryness may be the result of position on slope, of southern or western exposure, of coarse soil texture, or of lack of protective cover, or of a combination of these reasons. Plantation survival and growth on these sites (fig. 2) is not as good as on the sites described above. Invading hardwood species--persimmon, blackgum, and sassafras--are of less value than those coming in on the moister sites. Eastern redcedar also invades the dry sites.

Figure 1.--Ten-year-old shortleaf pine on moist, deep soil in an old field. The plantation has been heavily invaded by white ash, a hardwood of high site requirements.

Figure 2.--Good 10-year-old shortleaf pine about 18 feet high and 3 inches in d.b.h.; survival and vigor are fair to good. Soil is deep and fertile but dry, and the hardwoods which have come in are less valuable than those that invade the moist sites like the one shown in figure 1.

In special cases the effect of the position on the slope is accentuated by excessive or very rapid internal drainage through loose sand or loamy sand in the subsoil. Then survival the first year after planting is likely to be poor, because 15 or 20 days without rain may leave young, short-rooted seedlings without sufficient water. The trees that survive the first year, however, are likely to grow nearly as well (fig. 3) as those on moist sites. Poor survival in dry years may necessitate more replanting on these sites than on many others.

IB1. Soil deep; surface 6 inches mostly subsoil; moist.--These sites occur on lower slopes, in both old fields and gullies. Good moisture conditions result from their low position, medium- to fine-textured soils, north- or east-facing slopes, and protective plant cover or litter. In old fields such sites are recognizable from the fact that severe sheet erosion has removed most or all of the topsoil. Similar sites occur in gullies in recently abandoned fields, or in overgrazed pastures. Old-field plantings should be successful and produce satisfactory timber, with effective erosion control as a byproduct (fig. 4). Gully plantings may have only fair to good success, but probably will stabilize sand movement; timber can be produced as a secondary objective.

Figure 5 illustrates a common and important type of large gully with steep banks. Moisture as well as nutrient materials concentrate where the bank meets the gully floor. These spots are especially good planting sites. Soil is being deposited in the lower part of the gully and immediately below the outlet. This material contains enough topsoil to support good growth, and overlies deep parent material. The first planting should be on recent, somewhat stabilized deposition areas near the gully mouth (fig. 6) and in spots of moisture and topsoil concentration on the floor along the bank. Survival is likely to be low, but the trees which live will be vigorous and will gradually choke off the sand flow and cause it to be deposited further back from the gully mouth. If the new deposits of sand are planted every two or three years, the entire gully can eventually be covered and stabilized.

IB2. Soil deep; surface 6 inches mostly subsoil; dry.--These sites, like the preceding, occur in both old fields and gullies, but on the drier upper slopes and ridges. Dryness may be accentuated by coarse-textured soils, south and west slopes, and the lack of protective cover. Planting success is fair to good on these dry sites in old fields, where timber production is primary, but only fair in gullies, where erosion control is most important.

Figure 3.--Poor survival but good growth from 10-year-old loblolly pines planted on deep loamy sand that has rapid internal drainage.

Figure 4.--Good loblolly plantation on an old field that had lost most of its topsoil but had plenty of moisture and good subsoil. Note heavy litter cast by these trees, which are 35 feet tall and 7 inches d.b.h. at 14 years of age.

Figure 5.--This common type of gully must be planted piecemeal over several years. Fairly stable soil deposits, particularly near the mouth, should be planted first. When these trees have taken hold, another strip farther inside the gully should be planted, and so on until the entire gully is in trees. Other good planting sites are on the floor along the bank.

Figure 6.--A live dam of loblolly pines across a gully outlet. Trees are 10 years old. Although the gully is not stabilized, it no longer contributes heavy sediment to the stream channels it drains into. The new soil deposits in the foreground are ready for planting.

A dry-site gully of this class is pictured in figure 7. A small gully such as this can be planted straight across, all at one time, and at regular spacing. In 10 years' time, it should be well stabilized (fig. 8) if fire is kept out and there is no livestock or insect damage.

IIA1. Shallow soil (impervious layer always present within 24 inches of surface); surface 6 inches mostly topsoil; moist.--These sites are usually found on gentle lower slopes and bottoms in old fields. Moisture conditions are best where the soil textures are fine to medium, where there is some protective cover, and on north and east slopes. Planting success is good for pine timber production, and fair for hardwoods. In shallow soils, growth is somewhat dependent upon the weather. In wet weather the compact layer, or hardpan as it is sometimes called, tends to hold water, and the site becomes too wet. In dry periods these sites soon dry out. Shortleaf pine is likely to have tipmoth damage. If sheet erosion is not already controlled by minor vegetation before planting, it will be checked by needle litter and minor vegetation soon afterwards.

Sometimes sites of this category are wet because of very poor internal drainage. These wet sites are found on flat areas and small depressions and sometimes on bottoms. Trees planted on such sites are generally poor. There is ample topsoil but the soil is so waterlogged that aeration is poor and growing space is severely limited.

IIA2. Shallow soil; surface 6 inches mostly topsoil; dry.--These sites are found on ridges and upper slopes in uneroded or slightly eroded old fields. Dryness is accentuated by coarse-textured soils, south and west slopes, and bareness. Fair to good results may be expected for pine timber production.

IIB1. Shallow soil; surface 6 inches mostly subsoil; moist.--These sites are found on lower slopes, both in old fields and gullies. Moisture conditions are best with fine- to medium-textured soils, on north and east slopes, or under protective cover. Timber production on old field sites of this kind is only fair, but erosion control is a secondary benefit. In gullies, erosion control is the primary objective. Results may be poor to fair, with some timber production in the most favorable cases.

IIB2. Shallow soil; surface 6 inches mostly subsoil; dry.--These sites occur on ridges and upper slopes in old fields and in gullies. In such locations coarse sands, south and west slopes, and bare areas are especially dry. Even on old fields, planting of these sites is primarily for erosion control, with timber production--only poor to fair at best--of secondary importance. Erosion control is the only justification for planting such sites in gullies.

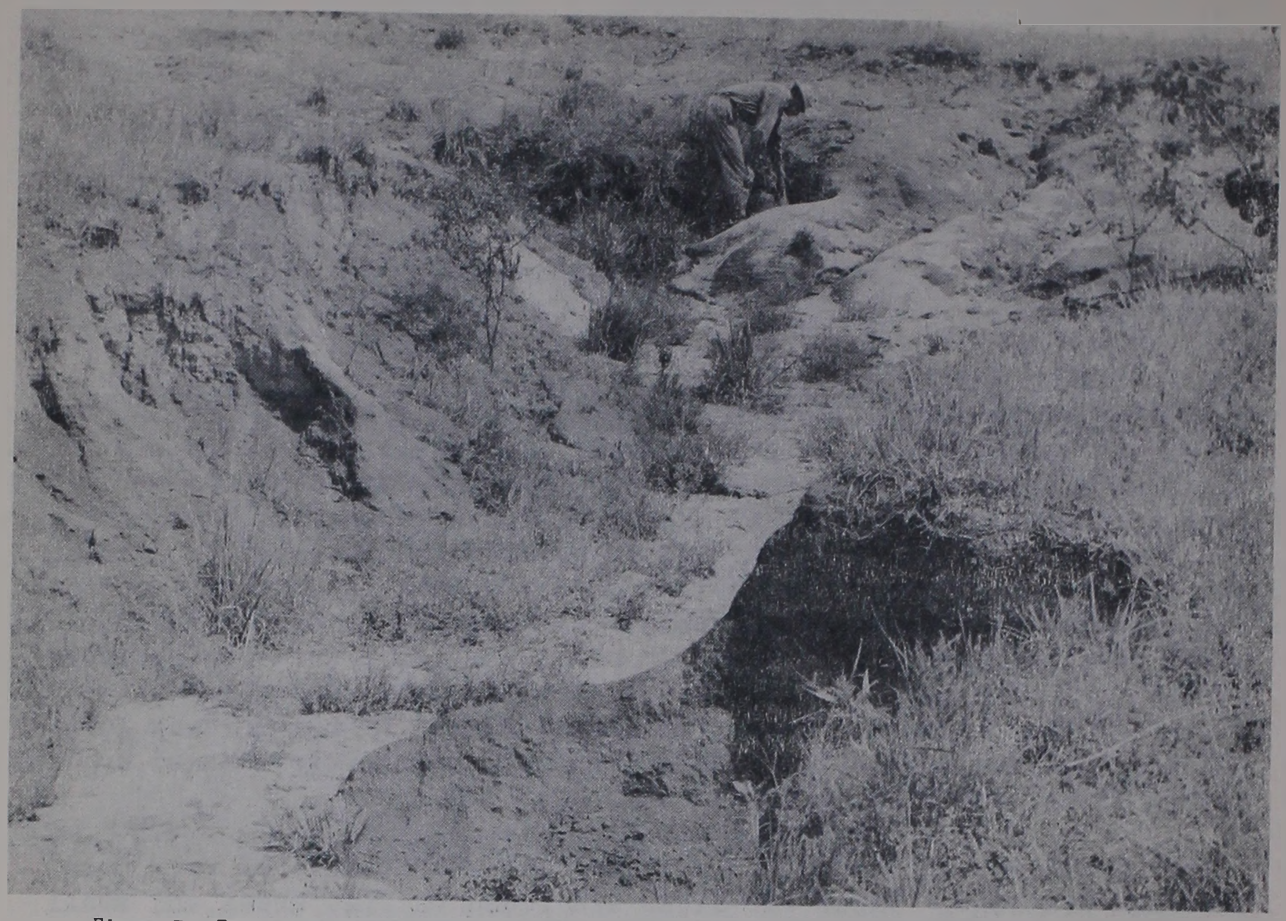

Figure 7.—This kind of gully can be planted all at one time, with tree rows going straight across.

Figure 8.—Gully like that in figure 7, but ten years after being planted to loblolly pine. This plantation is rated fair for timber. It has stopped erosion.

Figure 9.—Shortleaf 10 years old in a gully where the surface layer is mostly parent material. The shallow, low-quality soil has severely limited the feeding zone of the roots.

IC and IIC. Both deep and shallow soils; surface 6 inches mostly parent material; moist or dry.--These sites occur occasionally in old fields but usually in big gullies that seem to have gotten about as wide and deep as they can. Shallow, dry sites are most common. Often the surface is hard, cemented sandy clay, resistant to root penetration. This infertile material extends across the gully floor underneath a shallow covering of mixed materials. The roots find very little plant food, water, and air. In summer the soil surface becomes hot, often hot enough to kill tender young seedlings. Any moisture in surface layer is quickly dried out by the sun and wind.

Unless the sites are prepared in some way before planting, erosion-control plantations usually give poor results. Survival, growth, and vigor are low (fig. 9). Little or no litter is produced, ground cover is sparse, and the plantations fail to control erosion. Planting on deep silt loam parent material would probably give better

results than indicated in table 1, but inasmuch as such sites are extremely scarce in this category, there is not sufficient planting evidence to guarantee this prediction.

These sites must be mulched before planting. Mulch will prevent rapid loss of moisture by evaporation, extreme heating of the soil surface, and rain-drop splash, and will do much to increase success in erosion control. (See 15 for suggestions for preparing such sites.)

Tree Species for Planting

Loblolly pine.--Loblolly in most respects has been found to be the best pine to plant. Along with shortleaf and slash pine, it grows under the adverse conditions common to areas where erosion must be checked. Loblolly makes as good growth as any other species and produces more litter.

Under average old-field conditions loblolly crowns close at 10 years when trees have been planted at 6- by 6-foot spacings. In general, at this age the pines are reproducing and hardwoods are coming in under them (fig. 2). Loblolly shows the usual decline in appearance with decline in site quality but less so than other species. Lack of depth of soil necessary for full root development, particularly when caused by poor internal drainage, appears to be the principal limiting site factor for this species.

In gully plantings, loblolly does best on loose, sandy, erosive soil. The poorest growth is found on exposed hard, cemented, erosion-resistant material.

Shortleaf pine.--Shortleaf seems to do as well on adverse sites as loblolly, but its sparse litter production and slower growth make it less successful in stabilizing gullies and bare areas.

Shortleaf pine is very susceptible to tipmoth attack, particularly on the poorer sites. This factor certainly has reduced its growth rate.

Slash pine.--Slash pine probably grows as fast as loblolly and faster than shortleaf, but its survival is lower. Other things being equal, slash pines produce less litter than loblolly but more than shortleaf.

Slash pine planted in pure stands or on shallow soils appears to suffer more ice damage than other species. This should be considered when planting for timber production, but should not prevent its use when erosion control is the main objective.

Other pines.--A few small plantings of longleaf, Virginia, and northern white pine have been observed in this region. Although these species may have some future for erosion control, they have not had sufficient trial to warrant much optimism in the case of Virginia and longleaf pine, while northern white pine promises even less.

Eastern redcedar.--The few eastern redcedar (Juniperus virginiana) plantings observed in this region have been on very poor sites. Both survival and growth were poor. On fair or good sites redcedar should do better. Its natural occurrence in the old fields of this region indicates this promise. Redcedar has also been found to be a good soil builder. This fact plus the erosion control obtained from good stands should justify its further trial. Timber, or certainly posts, could be secured from the best plantings, but perhaps would be of secondary importance to erosion control and soil improvement.

Black locust.--Black locust shows considerable variation in growth and, in general, appears to be poorly suited for erosion control planting. When planted in gullies it fails except on deep, well-drained deposition areas, or in areas where moisture and nutrients have concentrated. Anything less than an optimum growing site means a sharp decrease in success both for wood production and erosion control. This generally poor showing, however, appears not to be due entirely to poor site conditions. The locust borer, twig borer, and leaf miner have severely attacked most of the plantations on poor sites. Some of the smaller trees are dead. Apparently they were able to survive the adverse site conditions but could not withstand severe borer and miner attack.

One effect of black locust should not be overlooked. That is the beneficial effect it may have on other plants growing nearby or in the planting mixture. Being a legume it can serve a useful purpose as a source of supply of nitrogen in closely-spaced plantings.

Other hardwoods.--Plantings of yellow-poplar, white ash, mimosa, catalpa, and black walnut show sharp variations in results. For good growth, these species appear to demand better sites than the pines do. The right amount of soil moisture seems especially important--there must be neither too much nor too little. For example, no good hardwood plantings were found on old fields located on ridges and upper slopes. On the same site, hardwoods will always look and grow less well than loblolly, slash, and shortleaf pine.

Recommended Planting Procedure

1. Evaluate the sites to be planted, and decide on the main objective of planting and the likelihood of success. For profitable timber production, plant the best sites described in this publication. On many sites of medium quality, forest planting controls erosion, and eventual timber production is possible. On the poorer sites, plant for

erosion control but do not count on getting much merchantable timber. On the poorest sites, forest plantations are unlikely even to control erosion without additional treatment.

2. Choose suitable species. As a rule, plant loblolly, shortleaf, or slash pine. Loblolly has proven most successful. Plant hardwoods only on fertile, moist soils. Introduced species, either pines or hardwoods, should be used only where local tests have shown that they will do approximately as well as the native pines.

3. Try to get stock grown from seed collected nearby, preferably within 100 miles of the planting site. Experiments have shown that plantations grown from loblolly pine seed collected 350 to 450 miles from the planting site produced only half as much timber as plantations from seed gathered near the planting site.

4. Make sure that the seedlings do not dry out or become heated during shipment or during storage between arrival and planting. Seedlings are packed for shipping with sphagnum moss or similar material. When the seedlings arrive, the roots and the moss should be moist and cool, and seedling roots should have no mold or discoloration. Seedlings stored for more than a day or two between arrival and planting should be heeled-in--placed in thin upright layers in moist soil, with the roots completely covered but with at least four-fifths of the tops above ground.

5. Space planted trees according to chances of success; plant individual seedlings where and when they have best chances to survive and grow. The usual spacing for forest plantations on farms in Mississippi is 6 by 6 feet. This is close enough for timber production on the best sites, where erosion control is no problem and high survival is assured. On the poorer sites, where considerable mortality is likely, and especially where trees must be established quickly to control erosion, spacing should be closer--but rarely closer than 3 by 3 feet. Spacing need be approximate only. On eroding areas, spacing should always be varied to set each seedling where it has the best possible chance to survive. Where possible, plant in spots of richer, moister soil. Plant on level spots, and avoid small humps where soil may be washed away from the roots, and hollows in which seedlings may be buried under new soil. Seedlings planted in small clumps of grass or weeds have a good chance for survival.

Deposits of soil near the mouths of gullies are normally very good sites, especially where the deposited soil is at least partly stabilized because of its location or of invading weeds and grasses. Trees planted in such places are especially effective in checking sediment (fig. 6). Planting should not, however, be extended beyond such spots to places where newly planted trees are likely to be covered by fresh soil deposits. Planting where deposition is active should be postponed until these new depositions have in turn become partly stabilized.

In gully planting, try to distinguish between gullies that can be stabilized by planting all at once (fig. 7) and those it is more effective and economical to plant piecemeal over several years (fig. 5).

6. Plant each tree carefully and correctly. Use either planting bars or mattocks. Set the root collar (which is marked by the change from greenish stem bark to yellowish root bark) at the surface of the ground or, at the most, ½ inch below it--never above. Be sure that the planting hole is at least as deep as the roots, that the roots are not doubled up, that the hole is firmly closed, and that the soil immediately around the seedling is left level. Keep seedling roots moist in bucket or tray during planting. Remove only one seedling at a time so that roots will be moist when planted.

7. Where necessary, take extra precautions to get the trees established. On bare, eroded areas, especially of the poorer, drier sites, mulch the surface with grass, straw, sawdust, or any available plant litter, up to 1 inch in depth. On deep soils, installing small check dams or soil-collecting trenches several months in advance of planting may increase the number of good planting spots. The use of various grasses and legumes both singly and in mixtures is generally recognized as a means of getting a quick cover on exposed surfaces; these usually need fertilization. Native herbaceous cover may be encouraged by the use of fertilizer alone. Soil quickly stabilized in this way will aid in getting trees established.

8. Furnish proper protection for the planting. All livestock should be fenced out of tree plantations. Fire must be guarded against.

9. Make reinforcement plantings. Replant where trees have died. Plant newly stabilized areas of deposition each year until the planting objective--erosion control--has been reached.